base, sont couchées en arrière et placées sur le plan du front; elles ont 10 centimètres de longueur. Le mufle est régulier.

Dimensions.

	mètre.
Longueur de l'occiput à l'extrémité du museau	0·26
Du bord de l'œil à l'extrémité du museau	0·14
Longueur de l'oreille.....	0·95
,, des cornes.....	0·10
,, de la touffe frontale	0·07

9. Heleotragus reduncus (Pall.).

Un mâle adulte de Huilla par M. d'Anchieta.

10. Hippotragus niger (Harris).

La tête d'un individu mâle envoyée de l'intérieur de Mossamedes par Welwitsch. Les cornes de cet spécimen ont 130 centimètres de longueur.

11. Strepsiceros kudu, Gray.

Deux individus adultes, mâle et femelle, envoyés vivants d'Angola et ayant vécu longtemps dans la ménagerie du Jardin de Necessidades.

Un jeune, de quelques jours à peine, né des précedents, tué par le mâle, qui était d'une grande férocité.

Une jeune femelle de Capangombe, par M. d'Anchieta.

12. Oreas canna, Gray.

Un mâle jeune d'Angola.

19. On the Structure and Development of the Trachea in the Indian Painted Snipe (*Rhynchæa capensis*). By J. Wood-Mason.

[Received June 18, 1878.]

(Plate XLVII.)

During the cold season of 1876–77, Lieut.-Colonel Godwin-Austen and I paid almost daily visits to the Calcutta bazaar for the purpose of making collections of the skins and skeletons of the numerous migratory and other birds which are at that season of the year caught and carried to market in such enormous numbers. On one of these visits my attention was attracted to a bird that lay conspicuous amongst its fellows of the same species by its greater size and more richly coloured plumage, by the low and regular, hoarse

but rich, purring call which, with breast puffed out, it was uttering—a call perceptible to the hand no less than to the ear. I at once recognized the smaller and less conspicuously coloured birds as specimens of one sex; and there seemed very little doubt, from its perfect correspondence in structure and general similarity in plumage, that the larger and handsomer one was an individual of the other sex of the Indian Painted Snipe (*Rhynchæa capensis*, sive *bengalensis*); but which of the two was the female and which the male, it must be confessed, I was at the time ignorant. In order that I might be enabled to determine the precise relation of the two forms to one another, and to ascertain whether any structural differences in their vocal organs accompanied the observed differences in their vocal powers—merely that I might know these facts of my own knowledge, certainly without the slightest hope or thought that I should be able, from such a cursory examination as alone I could give to it, to glean any thing new about so common an animal, I purchased a pair of the species.

Before killing the birds for examination, I referred to Darwin's 'Descent of Man'[1]; and what I read therein served but to increase my interest in the matter; for I soon saw that I had it in my power to corroborate or to contradict a statement which had been made about the trachea of this very species—the very part, curiously enough, the sounds issuing from which had drawn my attention to the bird.

It is well known that in many birds the windpipe, instead of taking a straight course from the *rima glottidis* through the interclavicular membrane to the point where it bifurcates to form the bronchi, is bent upon itself or convoluted, and that often to an extraordinary extent. The position of such flexures is very variable: "they may lie outside the thorax under the integument (as in *Tetrao urogallus*, some species of *Crax* and *Penelope*, and, I may add, the Manucodias[2] and the Rhynchæas), in the cavity of the thorax (as in some Spoonbills), on the exterior of the sternum (as in some Swans and Cranes), or even in a sort of cup formed by the median process of the furcula (as in a species of Guinea-fowl)"[3]. The increase in the length of the tracheal column implied by these convolutions, and other modifications of the windpipe, such as the swollen tympanum of Ducks and Geese, the air-sac of the Emu, may be dependent wholly upon sex; and the males may have the trachea more or less looped or more complex, whilst the females have it straight or simple, or only partially so, in which case the flexure or other modification may be more marked in males than in females. But however this may be, it is a general rule that whenever "the trachea differs in structure in the two sexes it is more developed and complex in the male than in the female"[4]; and it is a fact familiar to all that in the vast majority of instances it is the male which, in point of richness of plumage, vocal powers, and ornamental appendages, is the more highly

[1] *Op. cit.* p. 476.
[2] 'Nature,' vol. xv. p. 127.
[3] Huxley, 'Anatomy of Vertebrated Animals,' p. 315.
[4] 'Descent of Man,' *l. supra cit.*

endowed of the two sexes; but to this there are a few interesting and remarkable exceptions (*Phalaropus*, *Casuarius*, *Dromæus*, *Milvago*, *Climacteris*, *Eurostopodus*, and the Rhynchæas), of which the last, the ones we are here concerned with, are not the least conspicuous. In these birds in general, and in the Painted Snipes in particular, it may be taken as established that we have, to use the words of Mr. Darwin, a complete reversal not only of the secondary sexual characters, but also of the parental and incubating instincts—the females being not only larger and much more richly coloured than the males[1], but having the trachea more or less tortuous instead of straight and simple, deputing the duty of incubation to the other sex, and reserving the business of courting to themselves.

In *Rhynchæa australis*, according to Gould[2], the trachea, which is simple in the males, in the females passes down between the skin and the muscles of the breast for the whole length of the body, making four distinct convolutions before entering the lungs; but Mr. Darwin states, on the authority of Blyth, who had examined many specimens, that "it is not convoluted in either sex in *Rh. bengalensis*, which species resembles *R. australis* so closely that it can hardly be distinguished except by its shorter toes." This is the statement which seemed to me to stand in need of corroboration, especially when I called to mind the peculiar call of the female[3] and the sharp squeak jerked out only at long and irregular intervals by the male, and then apparently only in answer to the female.

On opening the necks of the two birds by a longitudinal incision extending to the middle of the breast or thereabouts, and carefully turning aside the skin on either hand so as not to disturb the natural relations of the underlying parts, I found that the trachea of the adult male (ascertained to be such by subsequent examination of the genital organs) was straight and simple throughout, whilst that of the female had a distinct loop lying between the integument and the interclavicular membrane on the left side, and was not only an absolutely but apparently also a relatively stouter tube than that of the male.

As the contrary of what I have found has been stated by so good and usually trustworthy an observer as Mr. Blyth, I put in evidence two sketches (figs. 1 and 2, p. 748) showing the course of the trachea in the two sexes. For these sketches I am indebted to Col. Godwin-Austen, who was with me at the time.

The numerous birds belonging to this species examined by me may be divided according to sex and age into the following groups:—

1. *Adult and probably old females*, remarkable for the extreme richness of their plumage. In all the birds of this group which

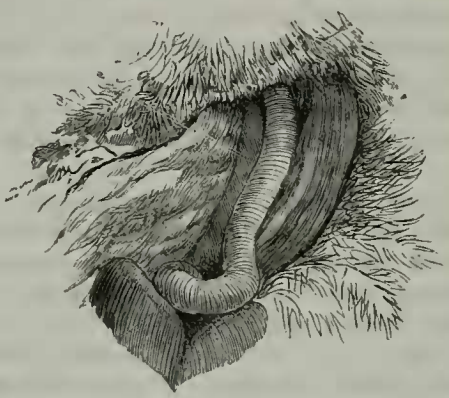
[1] Jerdon, 'Birds of India,' vol. iii. p. 677.

[2] 'Handbook to the Birds of Australia,' vol. ii. p. 275.

[3] Of *R. australis* J. Gould says (*op. cit.* p. 276), "The use of this convoluted trachea, so exclusively confined to the female, I could not in any way discover or surmise; no note whatever was heard to proceed from either sex while on the wing or when flushed"—times at which a call such as that of the female of *R. capensis*, like the coo of a dove, would be least likely to be heard.

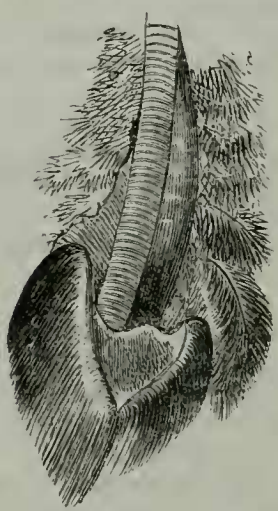
were purchased alive and killed and examined before muscular contraction had set in, the trachea was found to be looped as in fig. 1; a specimen living when obtained, but which died unexpectedly and in which decomposition had set in before I had had an opportunity of

Fig. 1.



Rhynchæa capensis ♀, dissected, so as to show its looped trachea *in situ*.

Fig. 2.



Rhynchæa capensis ♂, dissected, so as to show its straight and simple trachea *in situ*.

opening it, also had its windpipe looped; several, however, that were purchased dead had it retracted, almost straight, with the sterno-tracheal muscles strongly contracted.

2. *Females* not nearly so richly and deeply coloured as the preceding. In these there was only a slight superficial sinuosity in

the trachea, and the remarkable modification of the intrathoracic rings, to be presently described, had not proceeded so far.

3. *Immature females*, indistinguishable in point of plumage, though already larger than males. In all of these, without exception, the windpipe was found quite straight and simple throughout, though even at this stage females are infallibly to be distinguished from males by their stouter trachea, by the more powerful musculature of this, and by the more inflated condition of the delicate membranes connecting the bronchial half-rings with one another and with the three-way piece.

4. *Young, adult, and apparently old males*, all agreeing together in plumage and in the straight and simple condition of the trachea.

We shall see that the superficial loop which is invariably to be found in birds belonging to group 1 (*old females*) is the outward expression, so to speak, of a modification of the intrathoracic tracheal rings that takes place *pari passu* with those external changes which, when they are completed, mark the adult. But in order to make my description of this curious modification more intelligible, a few words, by way of preface, about the unmodified trachea of the male, or, better, of an immature female. If such a trachea be drawn through the fingers from end to end, a broad and shallow constriction will be felt near its posterior end, twenty rings or so from the compound three-way piece; the rings composing it are cylindrical instead of flattened, more than thrice as numerous as they are in an equal length of any other part of the tube, and so closely packed and firmly bound together as to possess little or none of that power of expansion and contraction which, by reason of their peculiarly bevelled ends, so eminently distinguishes the rest; it occupies a position as much within as without the thorax; and the great extrinsic muscles which pass between the sternum and the trachea, serving amongst other purposes as "guys" to keep the latter in place, expand and unite sheath-like over it, being inserted into it at numerous points, but especially at its anterior extremity; it is, in fact, the part of the trachea upon which the sterno-tracheal muscles directly pull when they contract, and thereby approximate the rings of the extensible intrathoracic portion of the windpipe in the adult female, to which we may now return.

On more closely examining the extrathoracic portion of the trachea in a bird in which that part is in the condition represented in fig. 1, p. 748, it can be seen that the loop is almost wholly composed of the constricted portion above described, and that the 2 or 3 rings that immediately succeed in order from before backwards (those situated at the point where the tube disappears within the cavity of the chest) suddenly get coarser and more prominent, and at the same time separated from one another by perceptible membranous intervals. On cutting away the sternum so as not to sever the sterno-tracheal muscles from their attachments, and so as to leave the furcula together with the membrane included between its two arms in place, the rest of the tube is displayed in a completely extended condition; it is then seen that the 12 or 13 rings immediately succeeding the coarser

ones which follow upon the fine-ringed constricted portion become suddenly still coarser and more prominent and convex, have lost their typical bevelled form, and are separated from one another by far longer and subequal membranous intervals. These are thin and transparent, and each is so constricted in the middle that any two consecutive rings form, with the membrane that connects them, a short hourglass-shaped figure. Six or seven coarsish rings, separated by much narrower membranous intervals, but otherwise unmodified, complete this portion of the tube, which is twisted spirally to the left, carrying spirally entwined with it the elongated sterno-tracheal muscles. The rings have come to be bent, and, instead of appearing as regular parallel bands as in other parts of the column, to be arranged obliquely, by adaptation, no doubt, to the spiral form taken by the tube whenever it is extended, so as, in fact, to present somewhat the appearance of having resulted from the breaking up into rings of what was primitively a hard spiral thickening of the walls of a membranous tube. Inside the thorax the spiral is necessarily very open, from the tube being restricted to a middle position by the membranous bands which sling it, together with the anterior moieties of its great contractor muscles, from the dorsal wall of the body, so as to form a sheath for it; whilst outside, in the neck, where is more room and more lateral freedom, it becomes closer, there constituting the well-marked superficial loop, the concave curvature of which is the true ventral surface of that fine-ringed portion of the tube over which the muscles spread, twisted out of its natural position.

If an adult female be killed with chloroform and rapidly opened, the sterno-tracheal muscles may be seen slowly to contract, and thereby gradually to take out the superficial spiral "turn" from the trachea, and the intrathoracic rings of this to close up, until at last all that remains of the loop is a slight sinuosity visible near the point where the tube passes into the thorax, the constricted and close-ringed portion, which occupied that position in the unmodified trachea, also having acquired an ineffaceable crook.

Unfortunately, we possess no more complete description of the highly convoluted trachea of the Australian species than that quoted above; but the two species *R. capensis* and *R. australis* are so very closely allied that we may feel tolerably confident that the tracheal modification is of the same kind in the two, only carried to a much greater extent in the latter, the constricted many-ringed part of the trachea of the former containing two or three potential convolutions.

In conclusion, I have to thank Col. Godwin-Austen for aid rendered to me in the matter of the illustrations.

EXPLANATION OF PLATE XLVII.

Fig. 1. The complete trachea of an adult female of *Rhynchæa capensis*, nat. size, showing the modified intrathoracic portion of the tube in an expanded condition. The compound three-way piece is seen to be formed by the partial fusion of the last tracheal ring with the modified first pairs of bronchial half-rings; these have their ventral ends

greatly expanded and produced backwards, so as to form by their fusion in the middle line a broad, flat, and squarish plate of bone strongly bilobed and tipped with cartilage at the hinder extremity, into which ossification extends with advancing age, rendering the posterior angles of the plate prominent, and bringing them into very loose relation of apposition with the much less expanded ventral ends of the second pair of bronchial half-rings; the ovoid saccular dilatations seen in figs. 3 and 4 result partly from the inflation of the membrane interposed between the ends of these half-rings and the posterior angles of the three-way piece, but principally from that of the ventral halves of the membranous inner walls of the second and third pairs of bronchial half-rings. The spatulate dorsal ends of the first pair of bronchial half-rings do not meet in the middle line, but curve inwards and backwards so as to leave between them a membranous interval, into which a narrow tongue of bone projects from the middle of the posterior margin of the last tracheal ring. In so small a figure no distinction between bone and cartilage in the three-way piece was possible. Drawn from a fresh specimen by Behari Lál Dós.

Fig. 2. A much enlarged view of a portion of the same, to show the form the modified part of the tube assumes when it is naturally expanded; the constricted portion (*a*) presents a singularly finely and regularly ribbed appearance, being composed of about forty very fine and closely packed cylindrical rings, all firmly bound together so as to form a stiff but still somewhat elastic mass.

Fig. 3. A much magnified ventral view of the posterior end of the same, to show the inflated condition of the membrane connecting the compound three-way piece with the second (apparent first) bronchial half-ring on each side, and also the two egg-shaped saccular dilatations (*e*, *e*) of the membranous inner walls of the bronchi.

Fig. 4. The same, from the left side, to show the egg-shaped dilatations (*e*, *e*) in profile, and the thin and narrow lateral slip of muscle (*l*) which is attached to the three-way piece at *m*, whence some of its fibres pass on to the second bronchial half-ring (*n*).

(All the three preceding figures were drawn under the microscope by the aid of a camera lucida, immediately after the death of the animal.)

Fig. 5. The complete trachea of an immature female, nat. size. The two sterno-tracheal muscles (*st.t*, *st.t*) are seen to be blended on the ventral surface of the constricted portion of the tube at *a*; *l*, *l*, are the lateral muscles, somewhat exaggerated in the drawing. Drawn by B. L. D.

Fig. 6. The posterior portion of the unmodified windpipe of an adult male, nat. size. The lateral muscles (*l*, *l*) are here so pale and transparent as to be all but undistinguishable in the fresh state.

Fig. 7. The same, much enlarged.

(With the two exceptions above mentioned, the figures of this plate have been obligingly drawn for me by Lieut.-Col. H. H. Godwin-Austen, by whom also the plate has been lithographed.

The following paper was read on June 4th, but was necessarily omitted from its proper place in consequence of the illustrations not having been finished in time:—